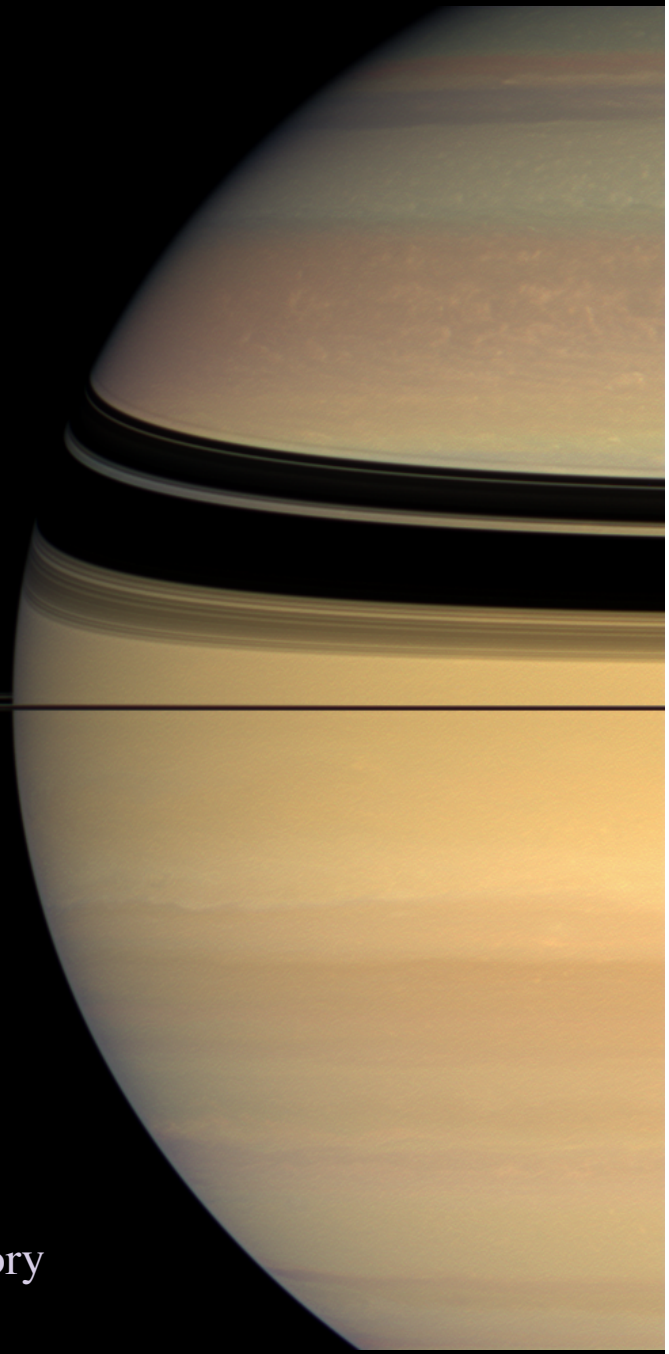
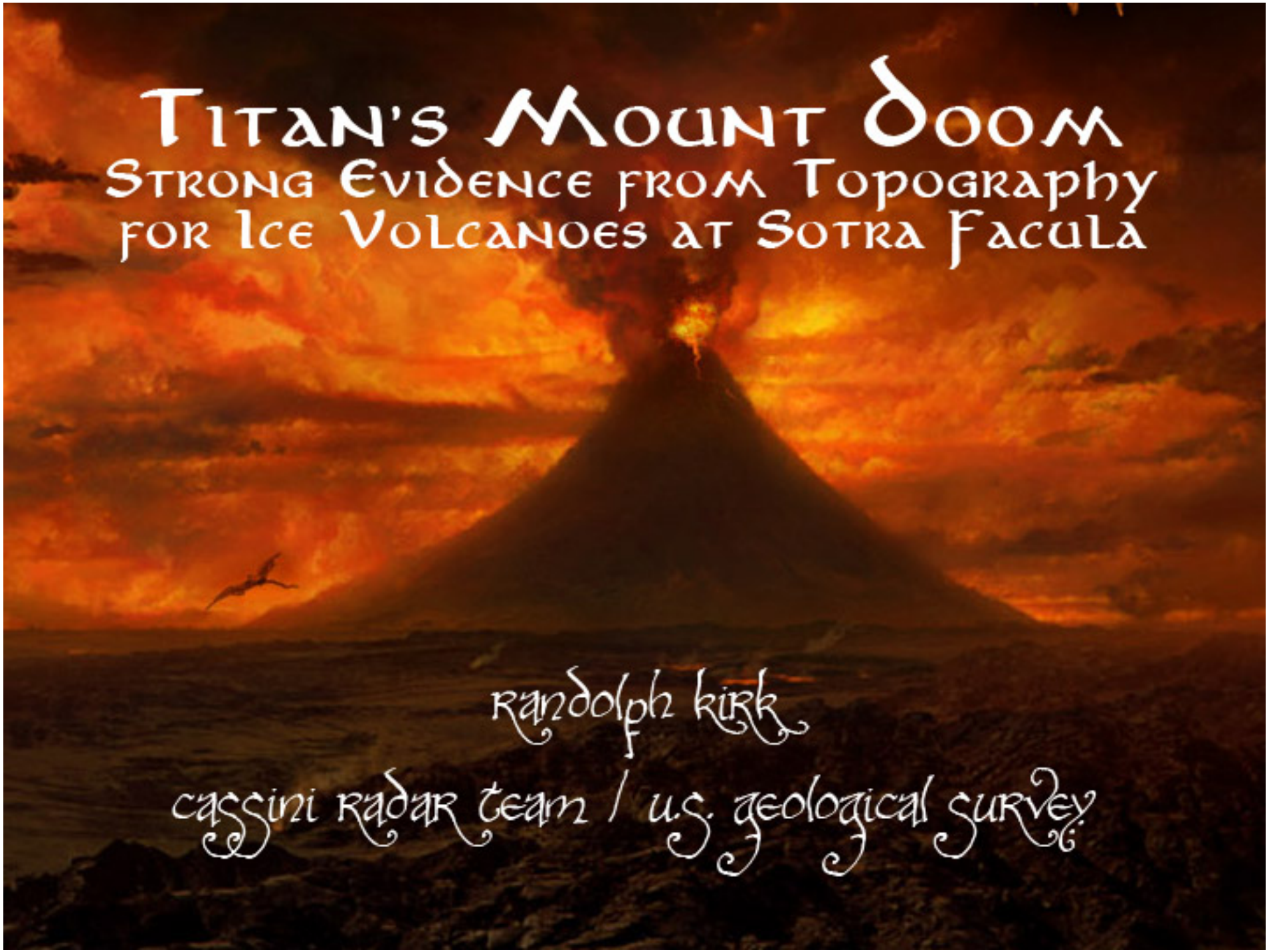
Ice Volcanoes and Hot Plasma Explosions



Highlights from NASA's Cassini Mission to Saturn

December 14, 2010

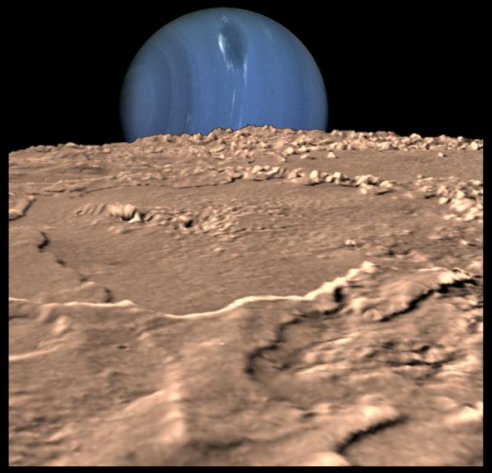
Media Contact: Jia-Rui Cook, NASA Jet Propulsion Laboratory
Cell: 818-359-3241 * E-mail: jccook@jpl.nasa.gov


Titan's Mount Doom
Strong Evidence from Topography
for Ice Volcanoes at Sotra Facula
randolph kirk
cassini radar team / u.s. geological survey

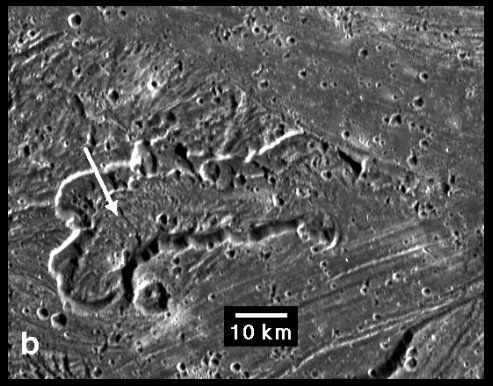
Cryovolcanoes (Ice Volcanoes)

- What is a volcano?
- What is a cryovolcano?
- Do they exist?
- Topography is an important clue

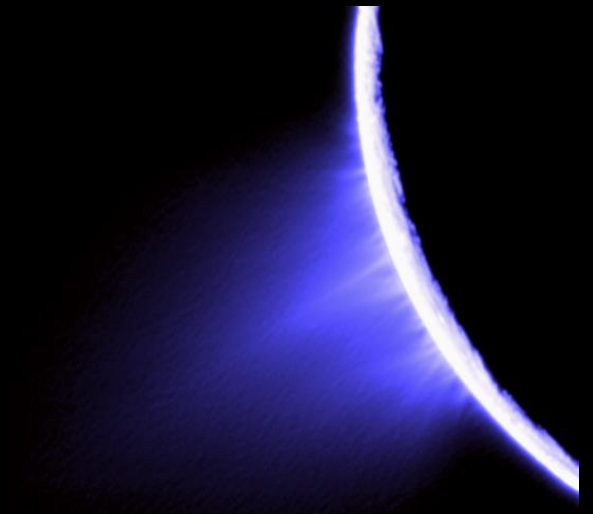
What would a cryovolcano look like?



Caldera? Triton

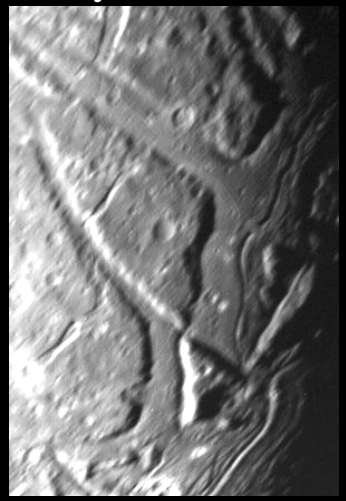


Caldera and flow? Ganymede

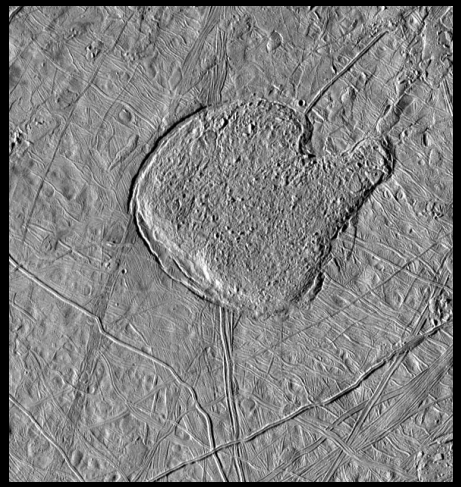


Actively erupting plumes, Enceladus

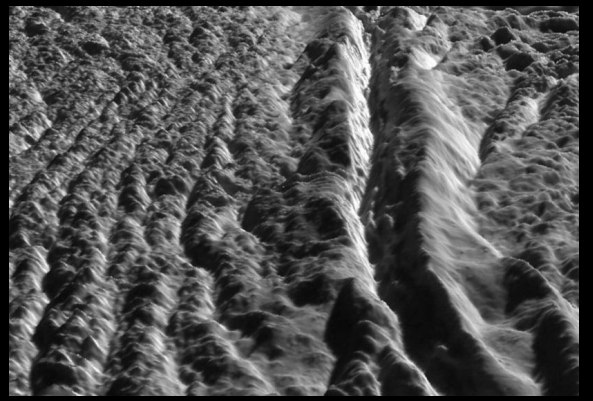
Valley fill, Ariel



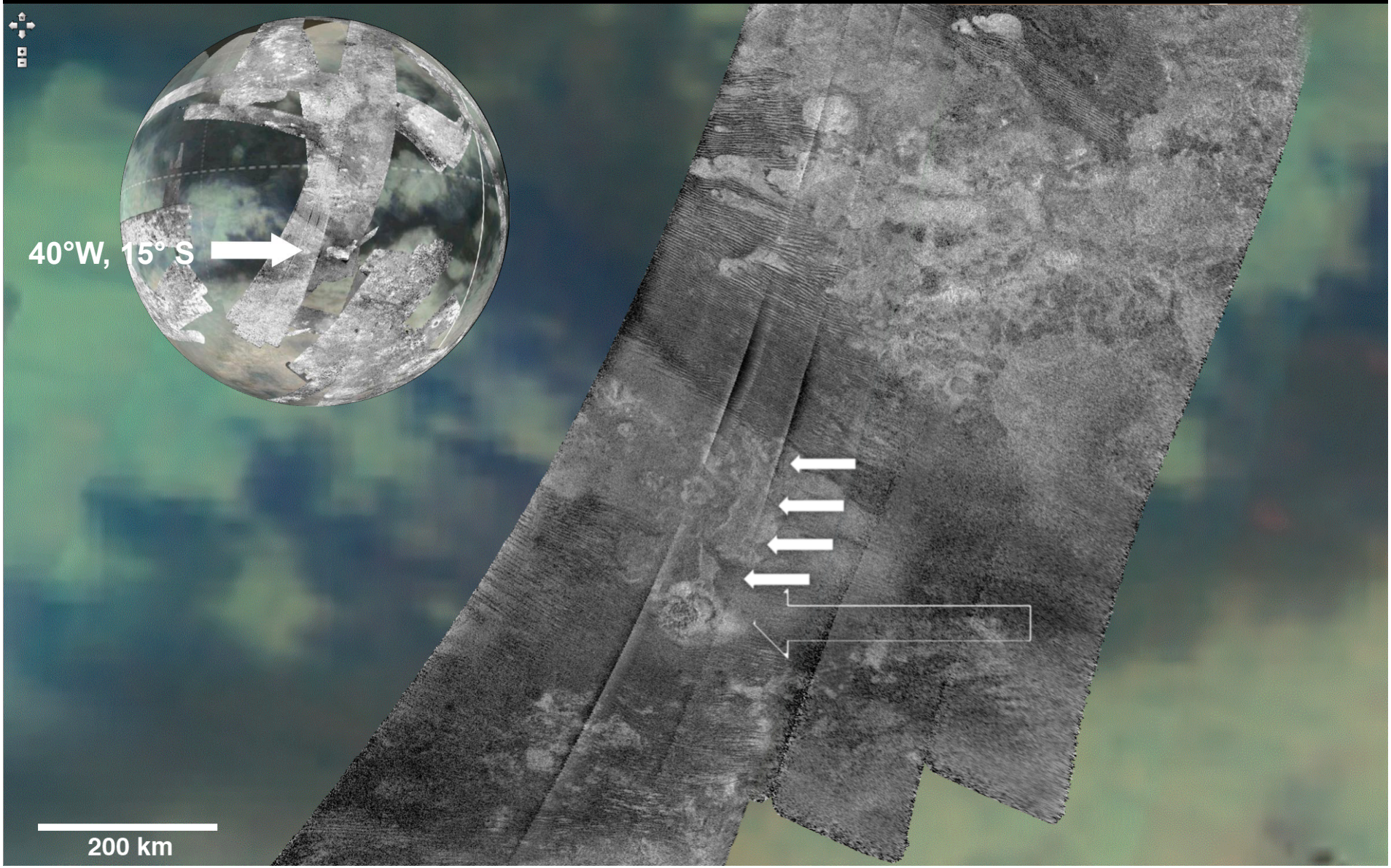
"Mitten," Europa



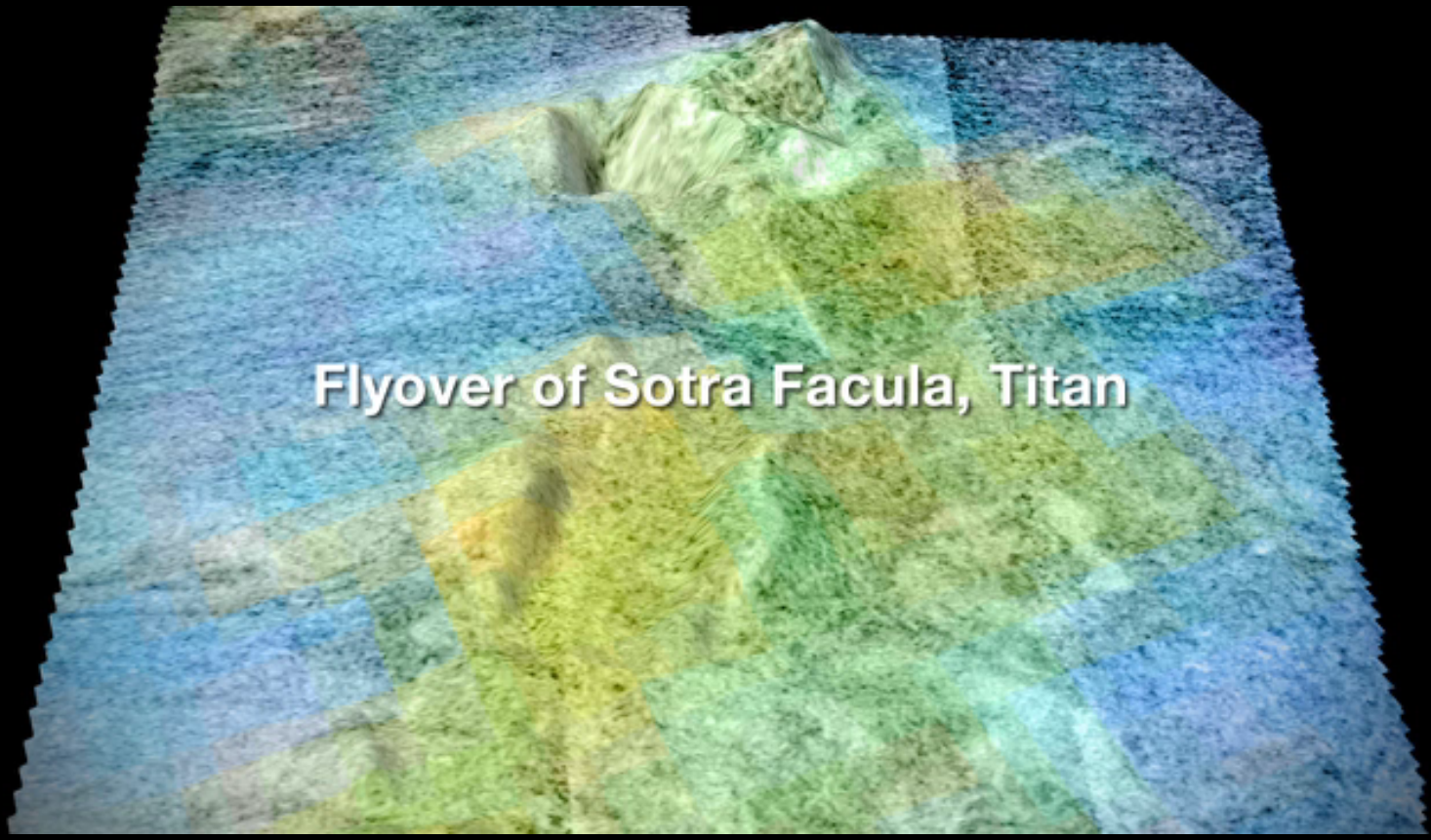
Plume source area



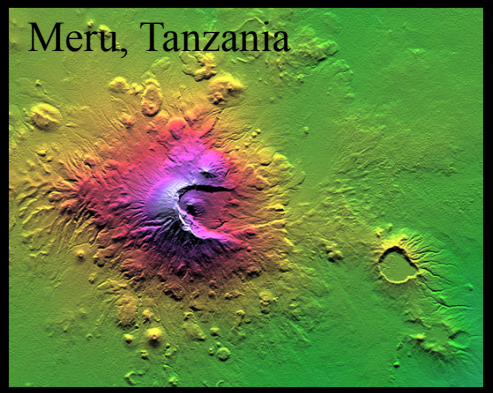
Sotra Facula:
A bright spot in Titan's equatorial sand sea

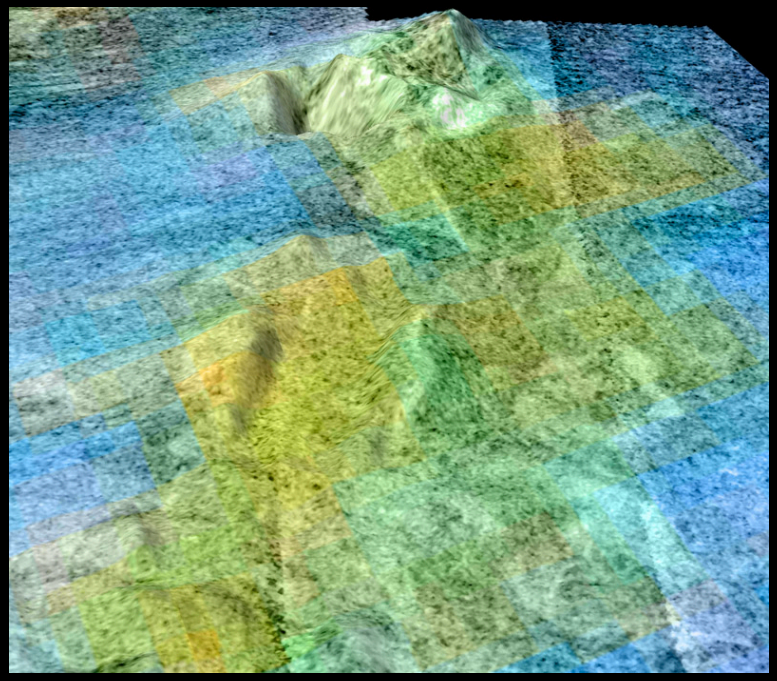


An earthlike volcano revealed

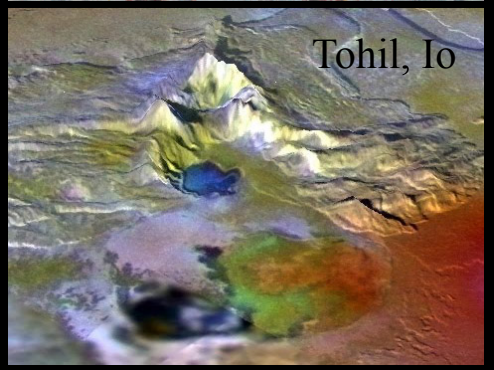


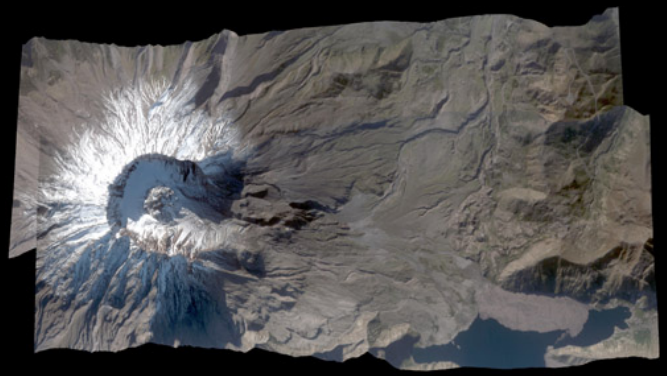
Some analogs for Sotra



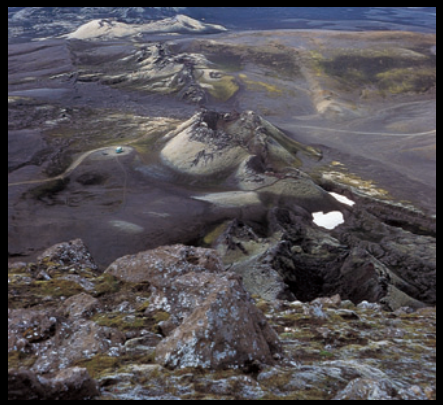


Sotra Facula, Titan

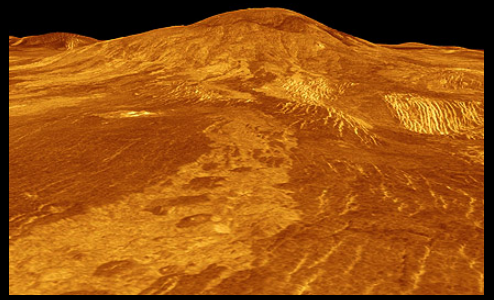




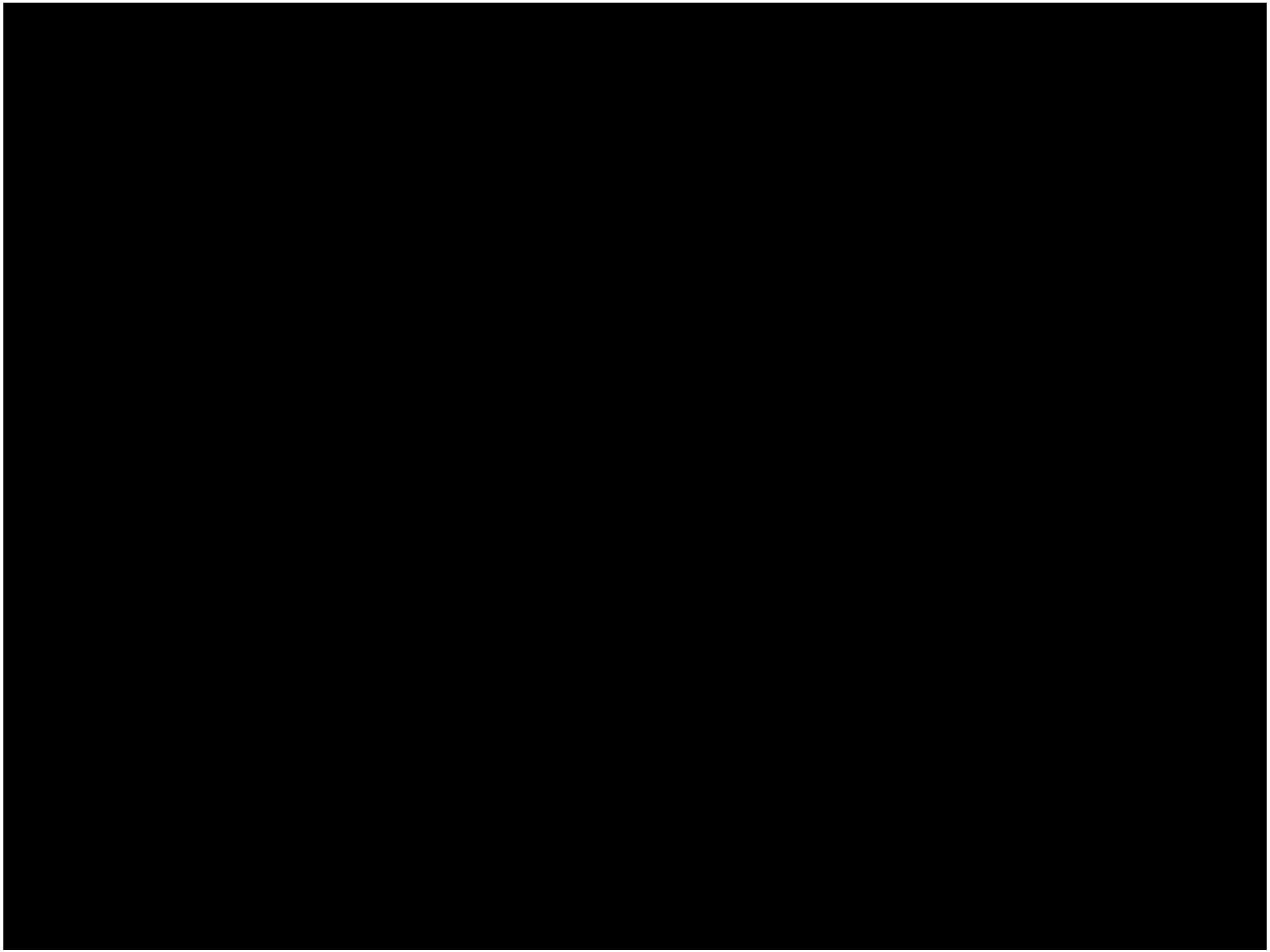
St. Helens, Washington USA



Laki, Iceland



Sif, Venus



Independent Assessment of the Discovery of a Cryovolcanic Complex on Titan: Sotra Facula

Jeffrey S. Kargel
Department of Hydrology & Water Resources
University of Arizona

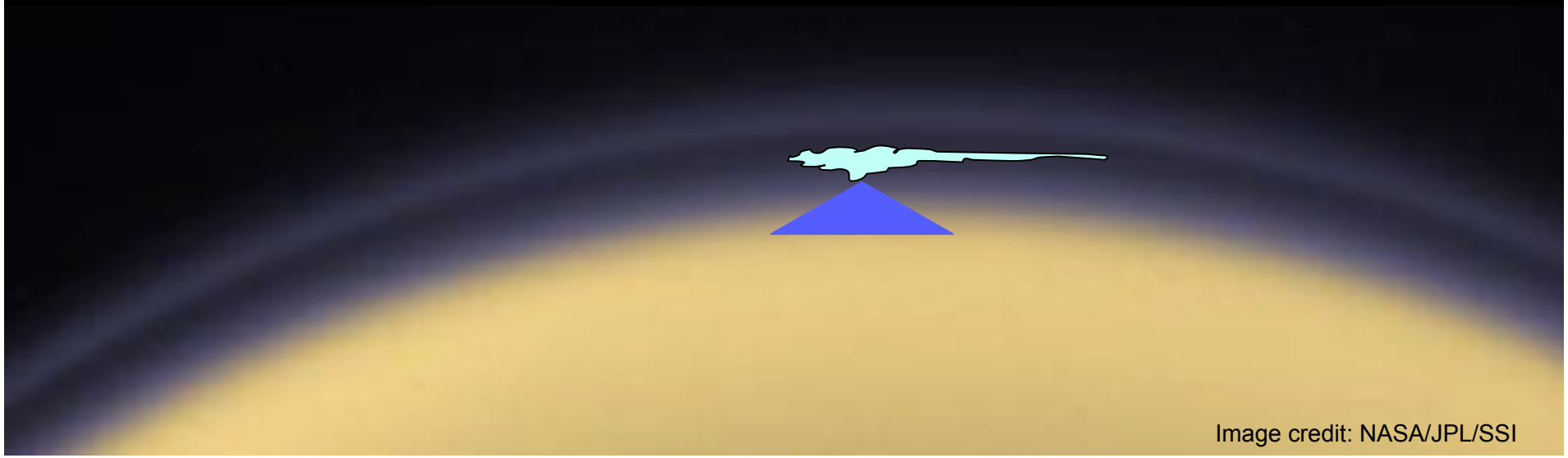
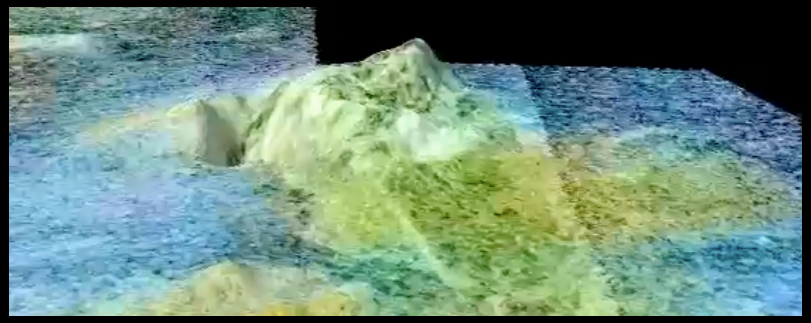


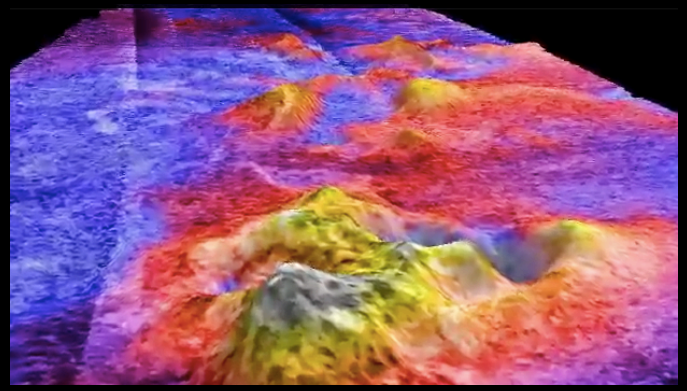
Image credit: NASA/JPL/SSI

Weak evidence for cryovolcanism:

-- Compositional distinction of mountains and the plains.

-- But this can be explained by either cryovolcanism or encroachment of dunes





Strong evidence for cryovolcanism:

-- Juxtaposition of some of the highest and lowest topography on Titan.

-- Few tectonic processes produce comparable conic mountains.

-- Mountains are organized in clusters and a lineament.

-- Associated depressions can be produced in several ways:

- *-- Volcanic explosions*
- *-- Collapse over emptying magma chambers*
- *-- Non-volcanic processes*

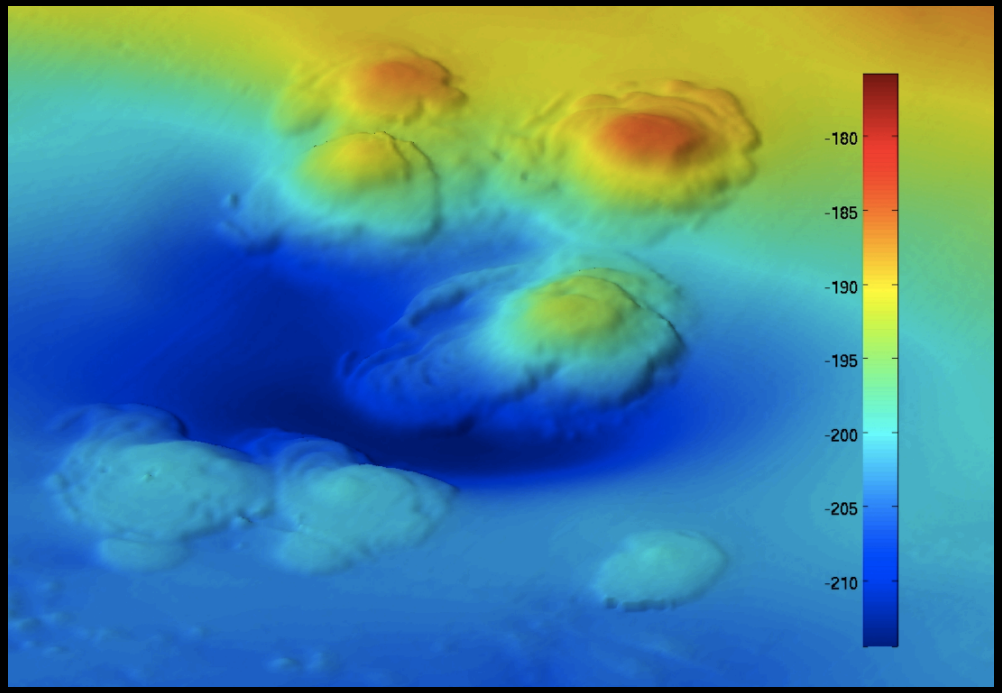
*-- **Cryovolcanism is the best overall explanation by far.***

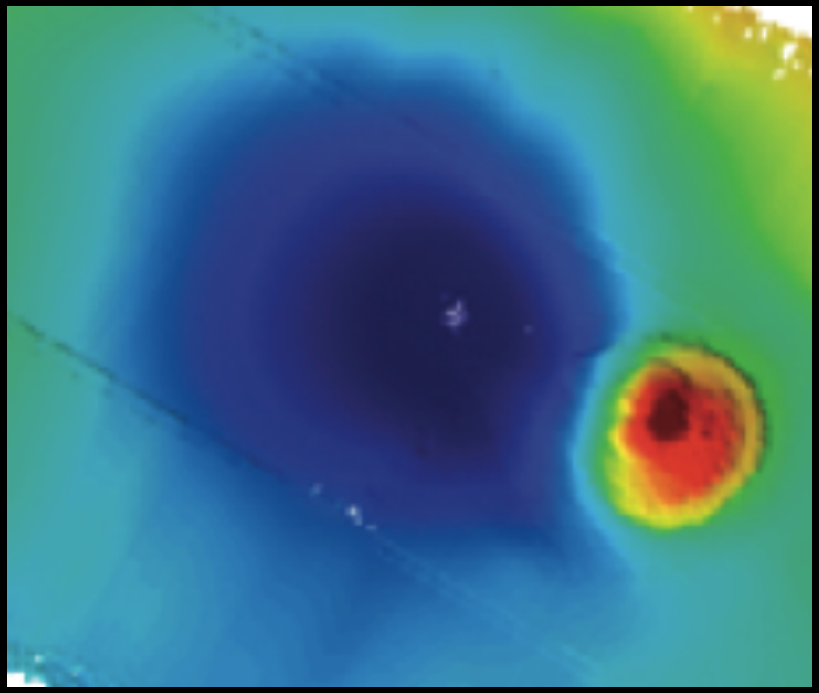
Two overarching classes of likely cryolavas:

I. Aqueous (water-based)

II. Hydrocarbons (think: softened asphalt, candle wax, and polyethylene)

Earth: Undersea Asphalt Volcanoes





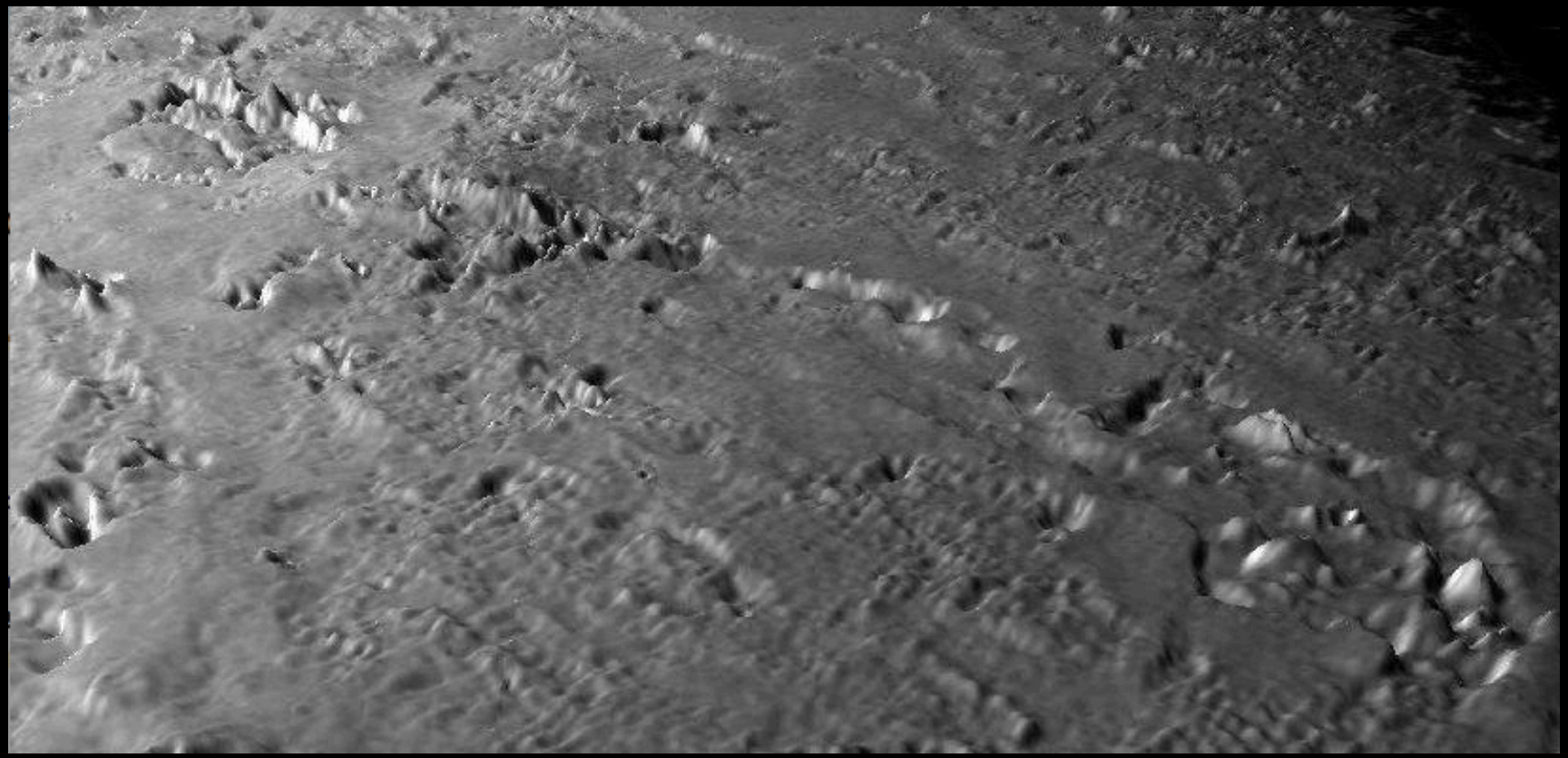
NSF Press Release 10-065:
Bathymetry shows extinct asphalt volcanoes and adjacent depression on the seafloor off California. Volcanoes are ~20 x 200 m.

Source: David L. Valentine et al., 2010, Asphalt volcanoes as a potential source of methane to late Pleistocene coastal waters, Nature Geoscience 3, 345-348.

See also: I. Leifer, et al., 2004, Transient discharges from marine hydrocarbon seeps: spatial and temporal variability, Environmental Geology 46: 1038-1052.

Triton: Cryovolcanic landscape

-- Voyager 2 image mosaic, scene width ~500 km
-- Some of the best prior evidence of mountain-building cryovolcanism.
-- Association of cones and pits in a rift-like arrangement is similar to that on Titan.
-- These cones on Triton are much smaller, ~10-20 km across, and not as well resolved.



Europa (from Galileo): Deposits (reddish) due to cryovolcanic eruptions of sea salts or battery acid onto icy plains (bluish), or not eruptions at all?

Are Titan's volcanoes are similar compositionally to Enceladus' water-carbon dioxide-methane plumes?

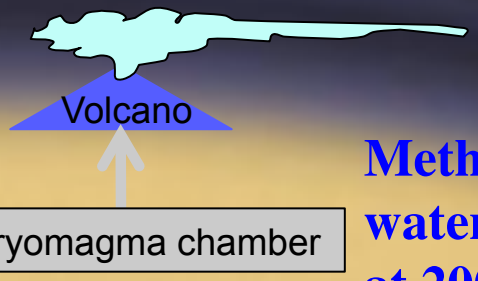
Image credit: NASA/JPL/SSI

If so:

-- Titan's atmosphere contains 10,000 X Sotra's methane emissions.

-- One "Sotra"/1,000 years needed to offset photolysis.

Ice volcano with other intermixed substances



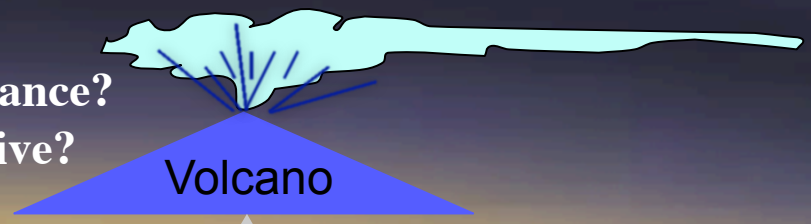
Methane saturation of water magma chamber at 200 bars (16 km deep)

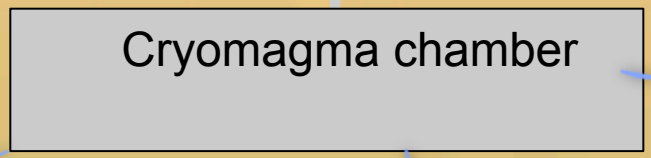
Sotra Facula is the best documented example of a cryovolcanic mountain.

Many unanswered questions and intriguing possibilities:

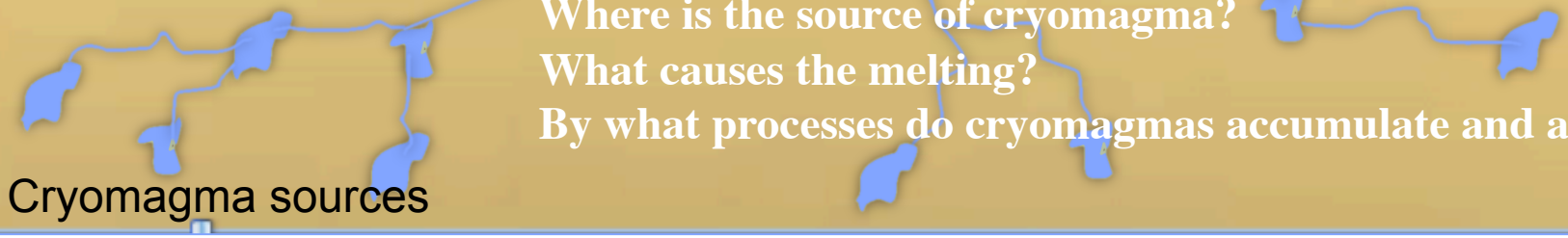
Is Sotra representative of the source of Titan's atmospheric methane?
Is cryovolcanism still active at Sotra or elsewhere on Titan?

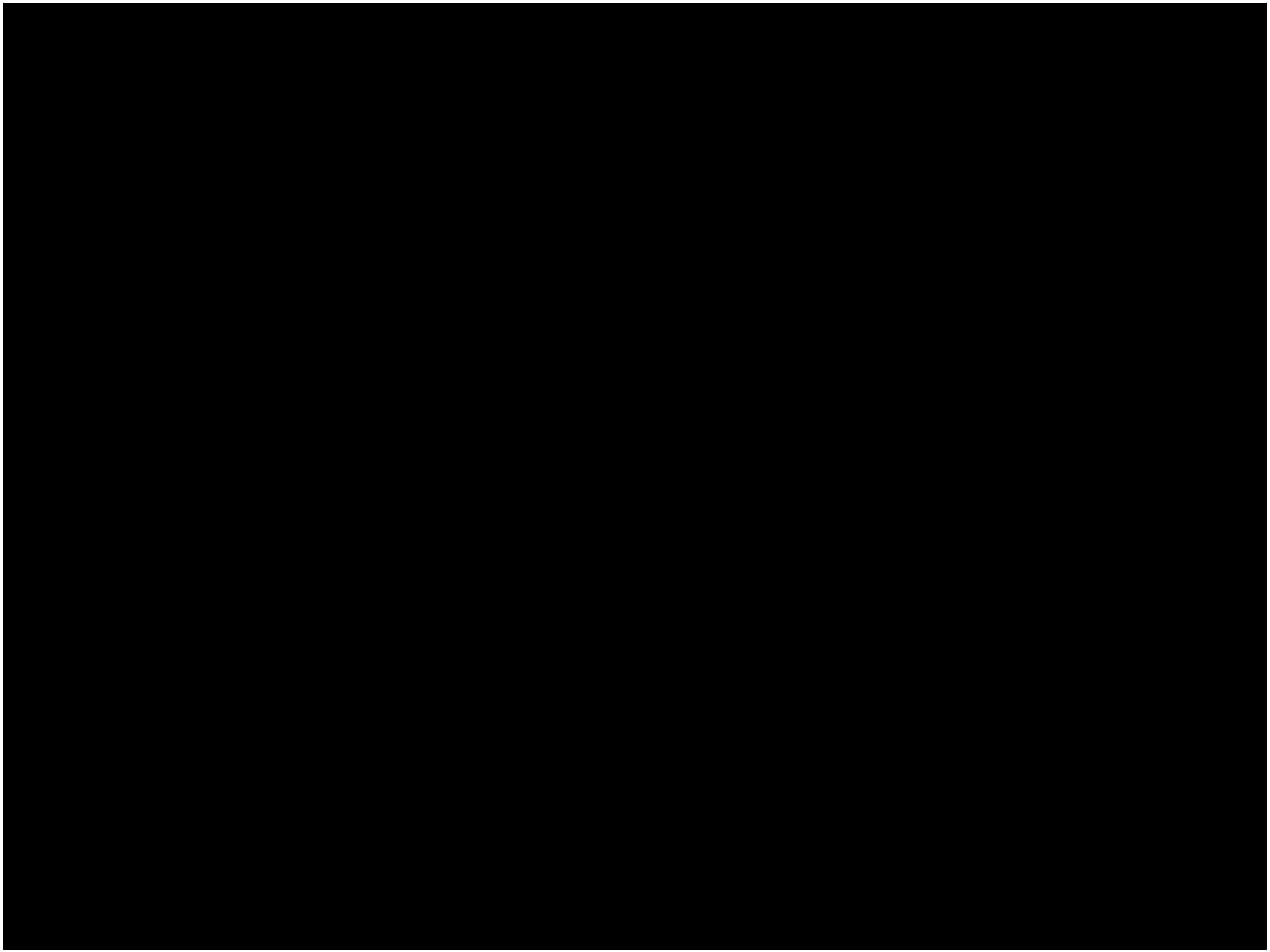
What is the cryovolcanic substance?
Is volcanism explosive or effusive?
What is the physical nature of the cryolavas?
Might the volcano contain evidence of subsurface life?





Where is the source of cryomagma?
What causes the melting?
By what processes do cryomagmas accumulate and ascend?





Pontus Brandt

Cassini magnetosphere imaging instrument (MIMI) team scientist

Senior staff scientist, Johns Hopkins University Applied Physics Laboratory,

Laurel, Md.

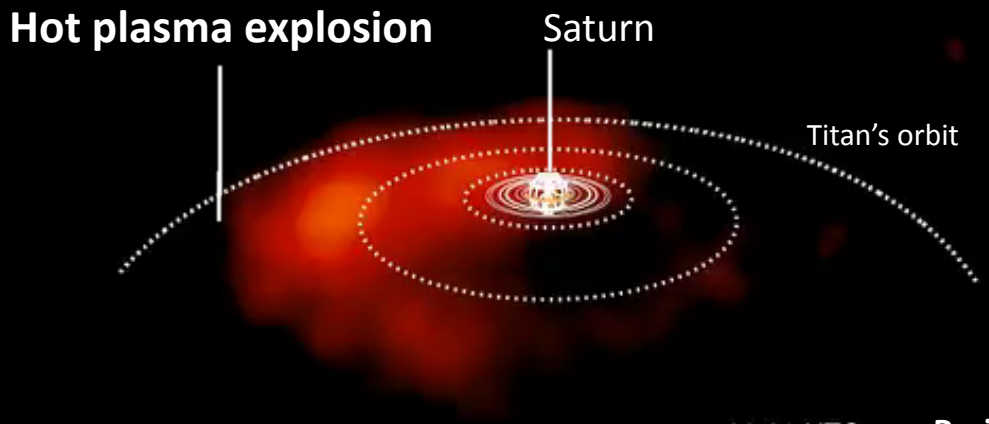
Saturn's Mysterious Periodicity

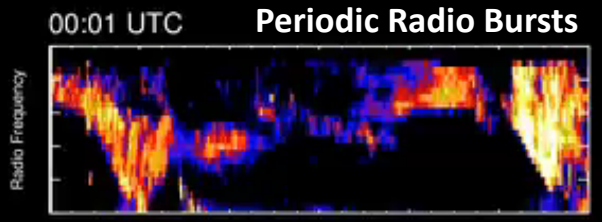
Periodic hot plasma explosions hold clues?

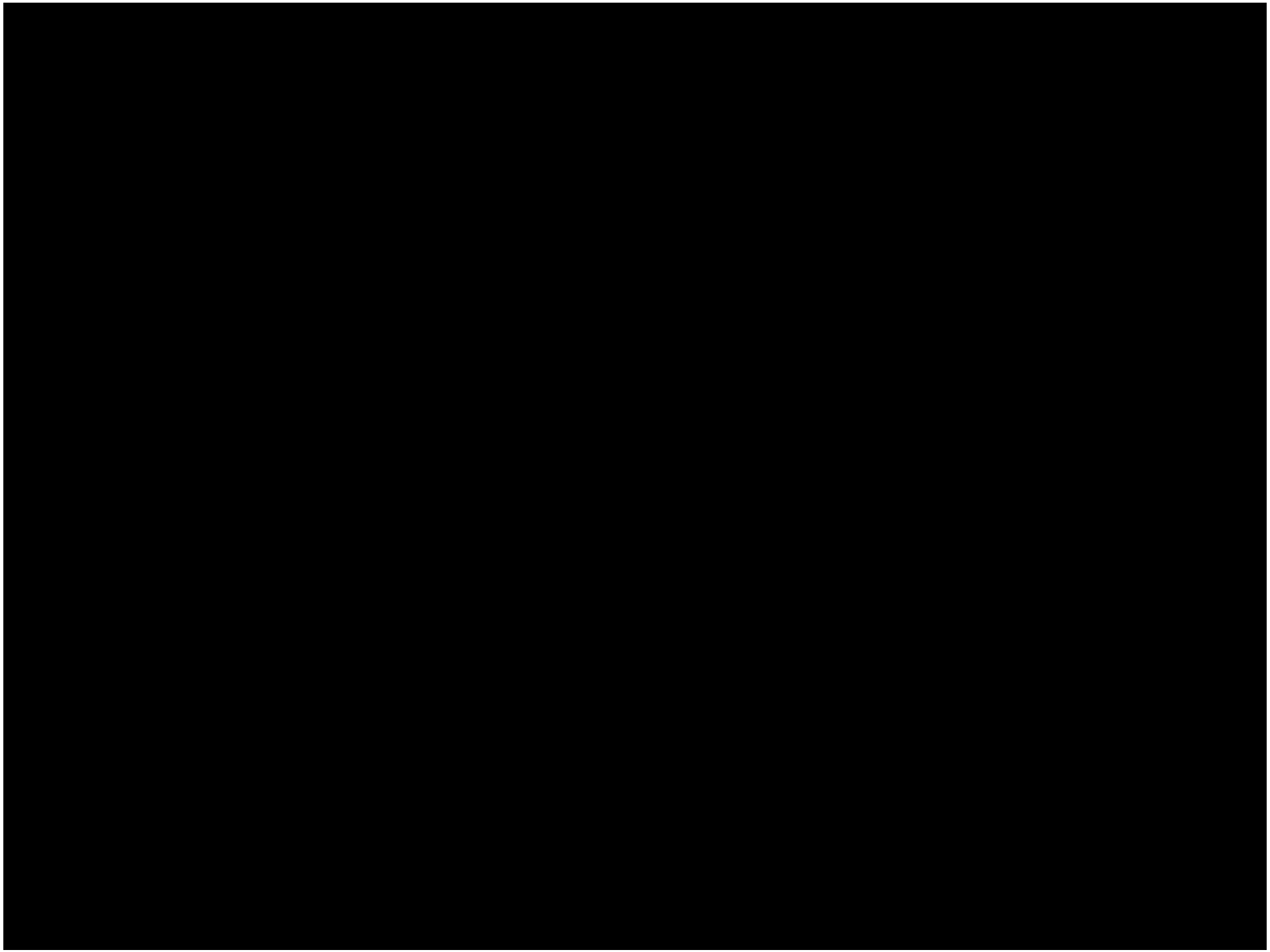
New results from Cassini unveil a relation between ***hot plasma explosions*** **in space and the periodic behavior Saturn's magnetic field and radio signals**

Why is this important?

- Periodic field and radio signals were believed to be a measure of Saturn's rotation rate, until it changed…
- The new result is a major missing piece that helps scientists understand the global and complex machinery behind Saturn's periodicities
- Also, it appears now that hot plasma explosions are a universal phenomena that make planetary magnetospheres giant particle accelerators





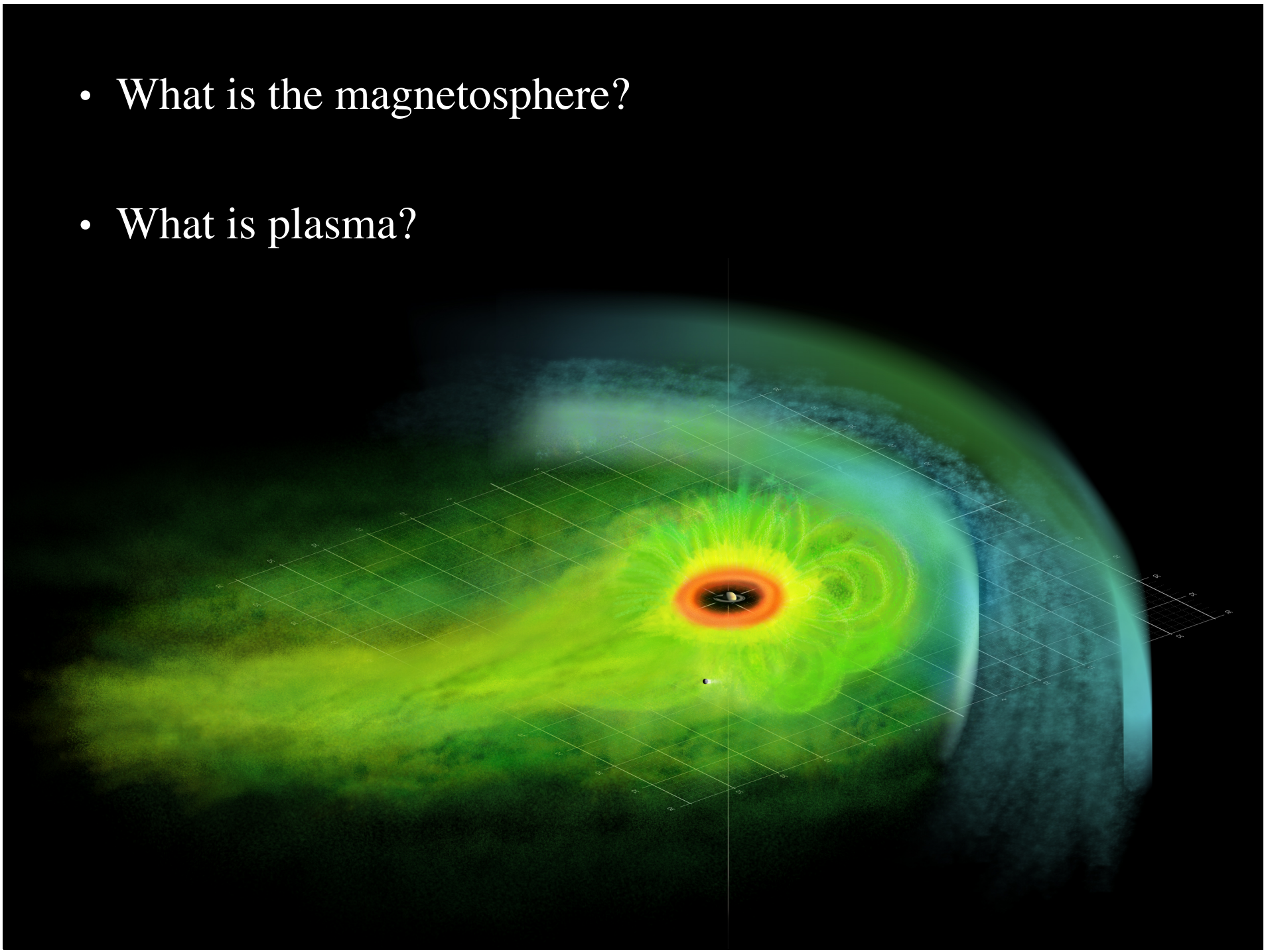


Marcia Burton

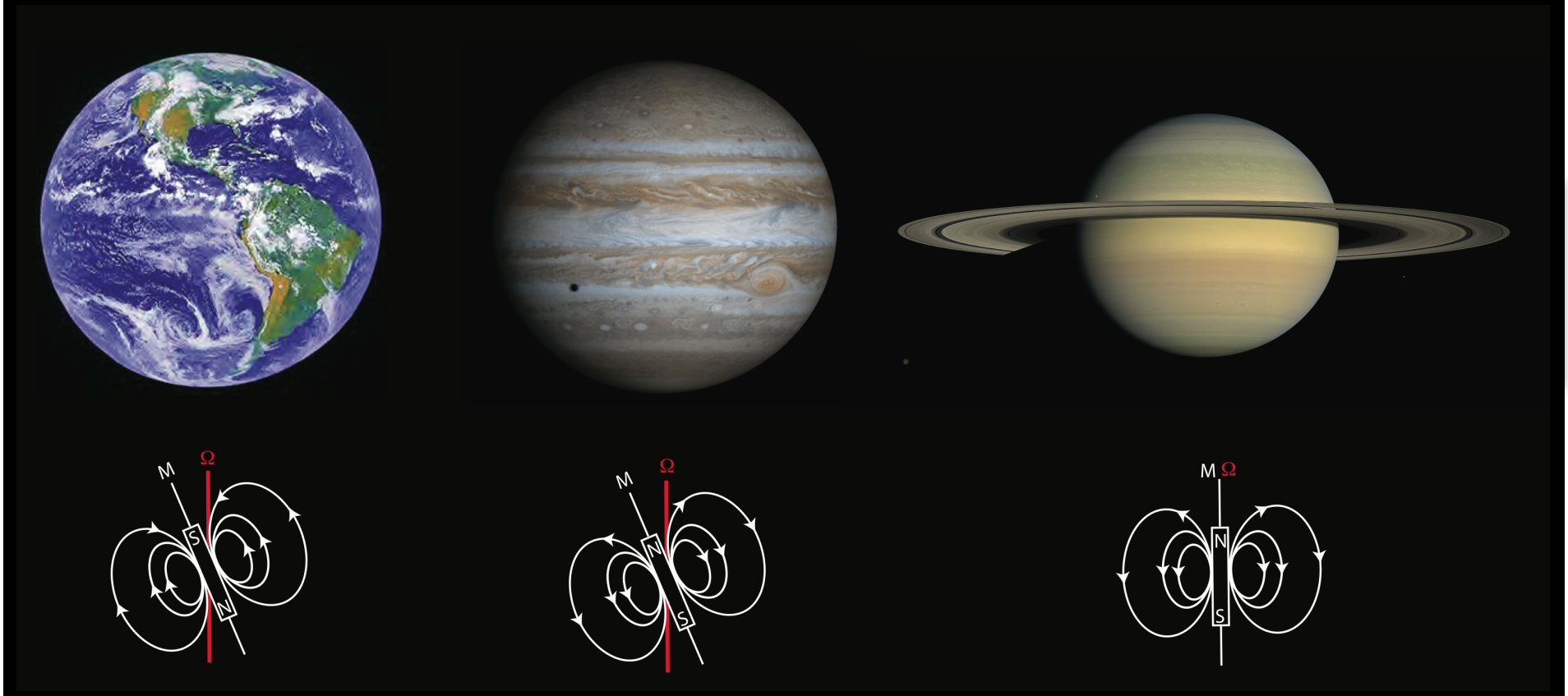
Cassini fields and particles investigation scientist

NASA Jet Propulsion Laboratory, Pasadena, Calif.

- What is the magnetosphere?
- What is plasma?



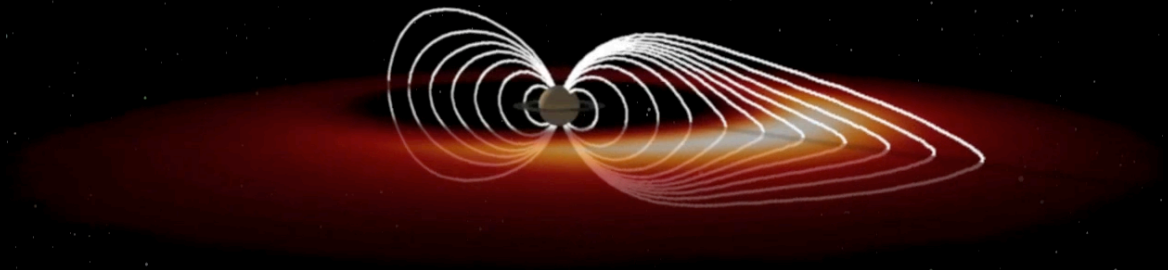
Magnetic Fields and Rotation Rates



What is the significance of the new work?

The work of Brandt et al. contributes to our understanding of periodicities observed in Saturn's magnetic field by establishing a causal relationship between the plasma 'explosions' and the observed periodic signature

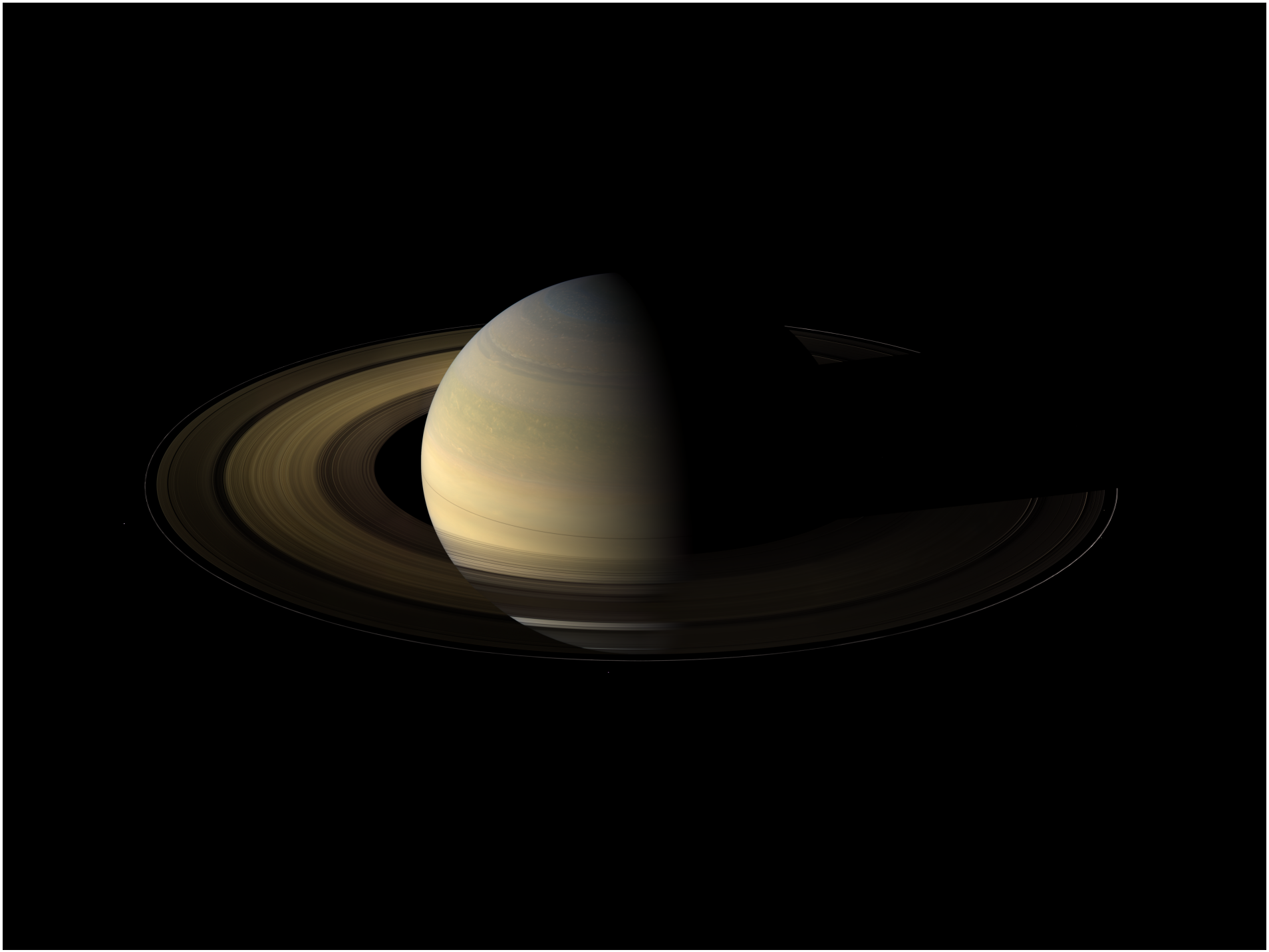
It is significant because it attempts to explain magnetospheric signatures that were previously thought to represent the rotation rate of the planet, but are now thought to mask the true rotation rate



Linda Spilker

Cassini project scientist

NASA Jet Propulsion Laboratory, Pasadena, Calif.



News conference images are available online at:

http://www.nasa.gov/mission_pages/cassini/telecon/20101214